# Energy Photovoltaics, Inc.

## Technology Partner

US DOE NREL THIN FILM PV PARTNERSHIP

### Background

In 1991, Energy Photovoltaics, Inc. (EPV), of Princeton, New Jersey, began work on thin-film $CuInSe_2$ (CIS) photovoltaic (PV) material with financial assistance from the National Renewable Energy Laboratory's (NREL's) Thin-Film Partnership Program. In 1992, NREL awarded EPV a research subcontract for approximately $600,000 per year for 3 years. During the contract period, EPV made major progress in developing a new, simplified method for depositing thin-film materials. It was during the course of this contract that EPV fabricated an 11.8%-efficient PV cell (Figure 1), fabricated its first interconnected submodules (9% efficient at 200 $cm^2$, Figure 2), and developed equipment designed for a 200-kilowatt (kW) per-year module pilot line for the production of larger modules (approximately 0.64 $m^2$). Recently, EPV (with support from the Sacramento Municipal Utility District [SMUD]) announced plans for a large module production facility in Sacramento, California.

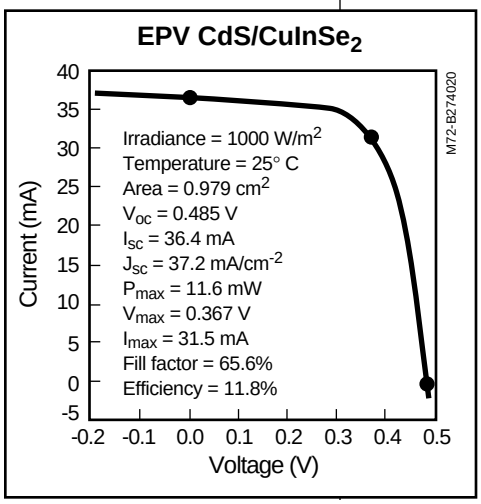


*Figure 1. EPV has made near-state-of-the-art thin-film PV cells using its innovative lower-cost fabrication processes.*

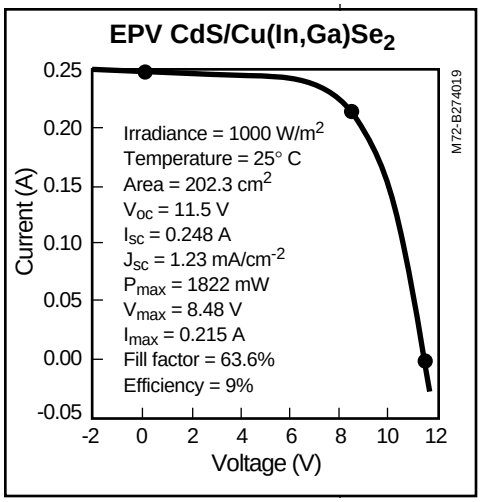


*Figure 2. EPV demonstrated the ability to fabricate larger-area submodules in preparation for pilot production.*

In 1994, EPV competed for and won a cost-shared research contract as a Technology Partner within the U.S. Department of Energy (DOE) Thin-Film Partnership Program. As a Technology Partner, EPV received 3 years of funding at about $1 million per year from DOE/NREL, while contributing about 20% in cost sharing. As part of the Partnership, EPV is participating with other awardees on the CIS Research and Development (R&D) team. EPV has achieved progress from start-up to precommercial technological success with the full partnership of the DOE/NREL program.

NREL's partnership with EPV is more the rule than the exception in terms of NREL's DOE-sponsored PV program. Through NREL-managed, competitive, cost-shared R&D subcontracts, NREL has "partnered" with the leaders in PV on the assumption that they will lead the way toward the true commercial success of PV. At the same time, NREL's in-house researchers have played a facilitating role, supporting near-term corporate progress while identifying and addressing key longer-term research problems.

### Technical Highlights

In order to make a new, viable PV product, EPV has had to address numerous key technical issues, such as (1) improved PV cell efficiencies, (2) high-yield film fabrication and processing techniques, (3) process quality control, and (4) outdoor reliability. These issues manifest themselves in terms of cell and module efficiencies, module scale-up (size and efficiency), prototype yields in pilot production, process rates and materials utilization, and outdoor and accelerated test results on modules. Figure 3 shows EPV's innovative low-cost CIS fabrication equipment. Figure 4 shows results of modules being tested by EPV outdoors for stability.

As part of their efforts to address key issues, EPV and NREL's in-house researchers have worked together to share NREL's expertise on CIS film fabrication and high-efficiency device design. NREL researchers hold the world record for the most efficient laboratory CIS cell: 17.7% in 1996. NREL has shared this expertise with EPV to assist in EPV's evaluation of different film fabrication techniques. NREL and EPV are working jointly on the CIS National R&D Team and have had a cooperative research and development agreement (CRADA) in this R&D area.

### Future Plans

Zoltan Kiss, the chief executive officer of EPV, says, "Our existence as a viable PV company has depended on the partnership that we have shared with DOE/NREL since our inception." DOE/NREL and EPV look forward to continued shared efforts to develop the EPV thin-film technology. The Thin-Film Partnership is designed to assist EPV in two important ways: by helping it to address key technical problems as EPV moves through the pilot production phase, and by working with EPV (and through the CIS teams) to maintain a high level of progress by continued technical development on improved "next generation" products.

In addition to the SMUD facility, EPV is seeking joint-venture funding to build an advanced thin-film module production facility. For high volume purchases of modules (greater than 10 megawatts), EPV anticipates a module price near $1.00 per peak watt, which translates into cost-competitive PV electricity generation for the U.S. peaking power market. Achieving these ambitious plans would be the fruition of EPV's "partnership" with DOE/NREL.

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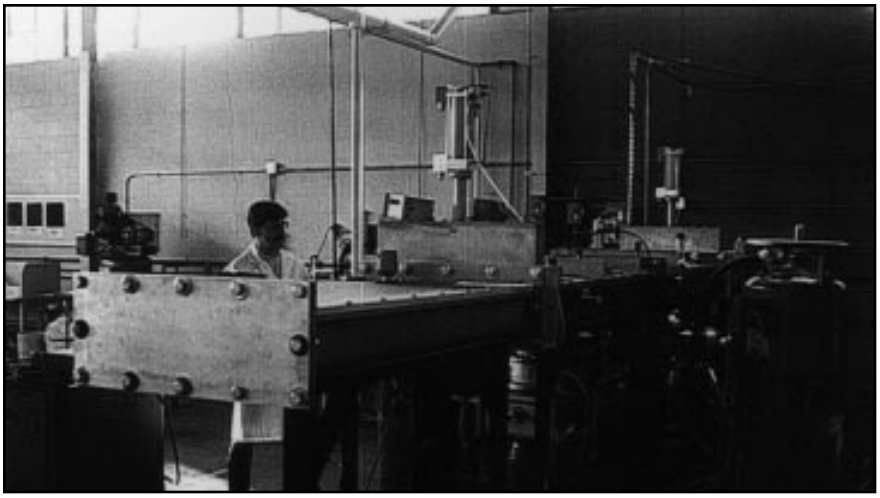

*Figure 3. EPV is developing equipment capable of fabricating large (about 0.64-$m^2$) thin-film modules for commercial production.*

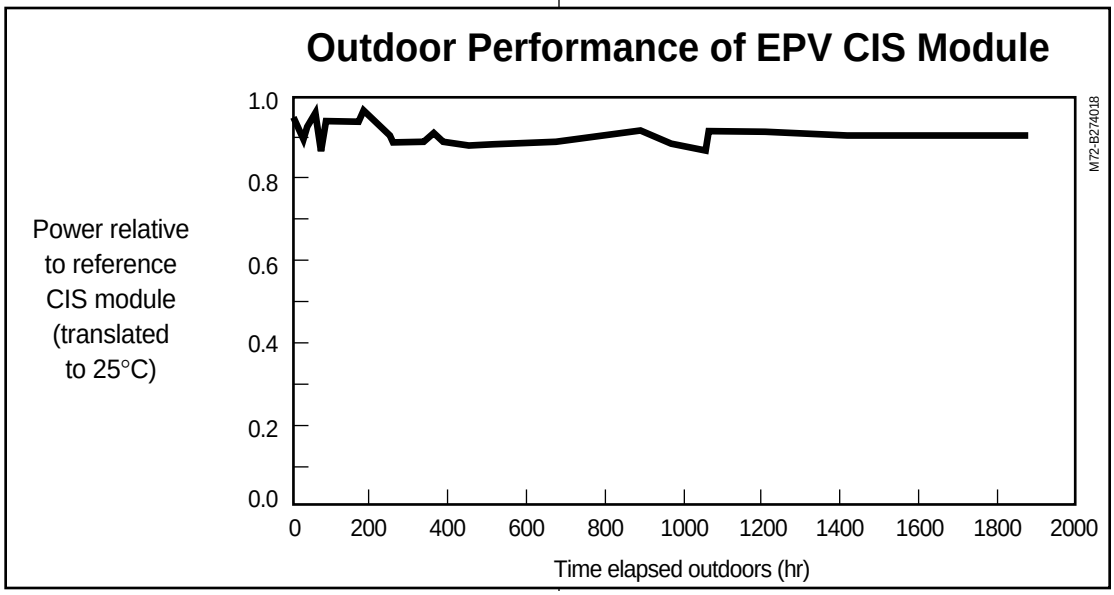


*Figure 4. The stability of the first fully encapsulated EPV modules has been excellent and consistent with the results seen elsewhere for this technology.*


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